CLAIMS

1. An apparatus for detecting an internal defect in an optical fiber, the apparatus comprising:

a detection light illumination device for illuminating detection light to the optical fiber from a direction that crosses the axis of the optical fiber;

an imaging device that takes an image of the optical fiber illuminated by the detection light from a direction that crosses the optical axis of the detection light, and outputs light intensity distribution signals in the radial direction perpendicular to the axis of the optical fiber; and

a defect detection section that obtains the light intensity distribution signals continuously in the axial direction of the optical fiber, and detects the internal defect based on the level of the light intensity distribution signals in the radial direction and the axial direction.

2. The apparatus according to claim 1, wherein more than two pairs of the detection light illumination device and the imaging device are arranged in the axial direction of the optical fiber, and the imaging devices are arranged at a regular interval around the optical fiber.

3. The apparatus according to claim 1, wherein the imaging device is a line sensor camera having plural imaging elements in line, and the detection light illumination device is located such that the light axis of the illumination light is in the opposite side of the line sensor camera with respect to the axis of the optical fiber.

4. The apparatus according to claim 3, wherein the defect detection section sets a detection start position in which the level of the light intensity distribution signal in the radial direction becomes more than a scan start threshold value, and sets a defect detection range based on the detection start pixel and the type of the optical fiber.

5. The apparatus according to claim 4, wherein the defect detection section sets the detection start position when the line sensor camera repeats to take the image of the optical fiber by a predetermined time.

6. The apparatus according to claim 4, wherein the defect detection section determines the existence of the internal defect based on the size of the portion in the defect detection range in which the level of the light intensity distribution signal is more than a defect judgment value.

7. The apparatus according to claim 6, wherein the defect detection section converts the light intensity distribution signals in the radial and the axial direction into binary data based on the defect judgment threshold value, carries out a blob process to combine the pixels corresponding to the position in which the light intensity signal is more than the second threshold value, and determines the existence of the internal defect when the size of the combined area is a first standard size or more.

8. The apparatus according to claim 7, wherein the defect detection section judges the internal defect as a microscopic bubble when the size of the combined area is a first standard size

or more and a second standard size or less, and judges the internal defect as a bubble in a drawing process when the size of the combined area is the second standard size.

9. The apparatus according to claim 1, further comprising a marking device to put a marking on the optical fiber at a position of the defect.

10. The apparatus according to claim 1, wherein the optical fiber has the diameter of 250μm or more.

11. The apparatus according to claim 1, wherein the optical fiber is a plastic optical fiber strand formed by melt-drawing a preform.

12. An optical fiber manufacturing apparatus having the defect detection apparatus according to claim 1, the optical fiber manufacturing apparatus detecting the internal defect in the optical fiber during the manufacture of the optical fiber.

13. A method for detecting an internal defect in an optical fiber, the method comprising the steps of:

(a) illuminating detection light to the optical fiber from a direction that crosses the axis of the optical fiber;

(b) taking an image of the optical fiber illuminated by the detecting light from a direction that crosses the optical axis of the detection light and outputting light intensity distribution signals over the radial direction perpendicular to the axis of the optical fiber;

(c) obtaining the light intensity distribution signals

continuously in the axial direction of the optical fiber; and

(d) detecting the internal defect based on the level of the light intensity distribution signals in the radial direction and the axial direction.

14. The method according to claim 13, wherein more than two pairs of a detection light illumination device for illuminating the detection light and the imaging device for taking the image of the optical fiber are arranged in the axial direction, and the imaging devices are arranged at a regular interval around the optical fiber.